DIXIEME RENCONTRE INTERNATIONALE DU GERPISA
TENTH GERPISA INTERNATIONAL COLLOQUIUM

La coordination des compétences et des connaissances dans l'industrie automobile
Co-ordinating competencies and knowledge in the auto industry

6-8 Juin 2002 (Palais du Luxembourg, 15, rue Vaugirard, 75006 Paris, France)

AUTOMAKER-SUPPLIER RELATIONSHIPS AND PRODUCTION ORGANISATION FORMS: CASE STUDY OF A BRAZILIAN ENGINE SUPPLY CHAIN

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INTRODUCTION

The recent restructuring of Brazil's automotive industry has motivated a series of studies covering a variety of themes on production management, production organisation and supply chain management. These studies address important academic and practical issues but, with a few exceptions, their purpose is not to engage in a detailed discussion of production organisation models or production organization forms. Our purpose, in this paper, is to identify the characteristics of at least some of the several areas that conform production organisation in the context of the relationships between an automaker and its suppliers.

The main justification for choosing this theme, besides the lack of empirical research on Production Organisation Structures (POFs), is the need to identify the characteristics of POFs of companies within the supply chains of Brazil's automotive industry following its extensive restructuring process over the last decade.

Alves Filho et al. (2002) explained how, in the 90s, the automakers gained in bargaining power over their suppliers, while a simultaneous concentration of capital and an expansion of multinational participation occurred in the autoparts sector. This paper examines the characteristics of POFs implemented at an engine assembly plant and at ten of its suppliers, listing some of the main conditioning factors that contribute to these types of organisations within this context.

To analyse the POFs of these eleven companies (production units), we carried out case studies to examine, in each case, what we call the elements of production organisation. These elements were: manufacturing strategies, technological strategies, work organisation structures, quality systems, logistics and supply chain management. Major items of information were collected from interviews with the managers responsible for the areas of manufacturing, quality, logistics and human resources.

In our examination of these elements, no attempt was made to identify every single characteristic of each element of the POF, but to describe the POF as whole, characterising the role of each element in the POF and discussing the influence, if any, of the engine assembly unit's POF on those of its suppliers.

After a brief overview of the context of Brazil's automotive industry, we discuss the main characteristics of the engine plant in question and of its supply chain, indicating the production organisation forms adopted by some of these eleven companies and the characteristics of the functional elements selected. Finally, we examine the relationship between the engine assembler's POF and those of its suppliers.

THE CONTEXT OF THE AUTOMOTIVE INDUSTRY AND SEVERAL ENGINE ASSEMBLY PLANTS IN BRAZIL

Automaker and autoparts investments in Brazil showed a sharp upward swing during the 90s in response to the rapid drop in inflation rates, the New Automotive Regime (a set of regulations implemented to attract foreign investments), and the automakers' expectations of continuous growth in Brazilian and Mercosur markets. After 1995, six multinational automakers

opened new plants (for passenger vehicle production) for the first time in Brazil, while the four automakers already operating in the country invested in new plants or in the modernisation of old ones. These investments are presented in greater detail in Alves Filho et al. (2002).

A characteristic peculiar to Brazil's automotive industry is that, as the result of an agreement signed in the early 90s by the industry, government and labour unions, the domestic tax on small passenger cars produced in Brazil (equipped with engines with less than 1.0-litre capacity) was reduced. This tax reduction has led to intensive competition in the so-called "popular car" market. We have seen, then, that automakers (whether or not recently arrived in Brazil) established new engine plants and/or modernised their old ones.

Within this context, automakers with different strategies in Brazil and in the Mercosur countries have established new passenger car and/or engine plants on Brazilian soil, resulting in the configuration of new and distinct autoparts supply chains.

Exclusively in terms of passenger car engine plants, 4 companies have established new plants (VW, Tritec, Renault, Fiat), either building a new plant in a new location or building a new plant next to an older one. Another two companies have just recently modernised their plants (Ford, GM). Table 1 indicates these companies' varying degrees of outsourcing.

One of our hypotheses, to be discussed elsewhere, is that, in addition to the specific relationships between automakers and suppliers, strategies and supply chain configuration are stronger conditioners of each company's production organisation form. In this paper, our purpose is simply to identify and discuss the production organisation forms (POFs) implemented at some plants of a specific engine supply chain. To this end, an exploratory study was made to identify the POF of a specific engine assembly plant and those of its suppliers.

Table 1 - *Several engine assembly plants and the source of their engines' main components*

Assembly Company (engine)	Engine part					
	Cylinder block	Engine block machining	Crankshaft	Overhead camshaft	Cylinder Head	Piston rod
Volkswagen S. Carlos[a]	outsourced	In-house	Imported	outsourced	outsourced	outsourced
Ford Taubaté[b] (Zetec Rocam engine)	Internal	In-house	Other Ford units	…	In-house	Other Ford units
GM S.J. dos Campos	…	In-house	Machined in-house	Machined in-house	Machined in-house	Imported
Fiat Betim (new FIRE engine)	Company of the same group	External machining done at Company of the same group, internal machining done in-house	Machined in-house	outsourced	Machined in-house	outsourced
Fiat Betim (FIASA engine)	Company of the same group	In-house	Machined in-house	Machined in-house	Machined in-house	Manufactured in-house
Tritec Campo Largo	outsourced	In-house	Outsourced and machined in-house	…	Machined in-house	Imported from the US
Renault	outsourced	In-house	Outsourced and machined in-house	outsourced (not cast, but produced in a tube shape)	Machined in-house	Machined in-house

[a] the data in this column refer only to Volkswagen's 1.0-litre engine

[b] around 60% of engine components is manufactured by Ford (approx. 30%) and by Visteon (approx. 30%), a company owned by the Ford group.

CHARACTERISTICS OF THE ENGINE PLANT AND ITS SUPPLY CHAIN

The engine assembly plant was built initially to produce 1.0-litre engines, but it later expanded its production to include other types of engines, thus increasing its product mix. Today, the factory is staffed by approximately 450 people and by 250 supplier employees (from several service areas), producing approximately 2800 engines/day in 2 daily shifts.

This engine plant uses an intermediary level of outsourcing (mid-way between the modular consortium and the traditional supply chain), and its level of partnership (or cooperation

with suppliers) is also intermediary in that there is no single supplier with a long-standing relationship, although no more than two suppliers are selected for any given item. The rationale underpinning the decision to have one or more suppliers involves issues of scale production, technological capacity, the establishment of a certain degree of competition between suppliers, and guaranteed supply.

The factory produces a relatively large (for only one plant) set of engines, whose manufacturing process comprises a block machining stage and two engine assembly stages. The installed equipment incorporates up-to-date technology with a high level of automation for Brazilian standards. Several other activities are also outsourced at the plant itself, e.g., the tool shop, internal transportation of materials, external logistics, waste control, part of human resources management, the cafeteria, etc.

This high level of outsourcing allowed for much lower initial investments, and apparently, a lesser impact than other automakers faced as a result of the fluctuations of the automotive market. The characteristics of the factory's supply chain are determined by this level of outsourcing and by the company's supply policy. Some of these characteristics are: (i) with the exception of the cylinder head, the remaining engine components cannot be considered subsystems (as in the case of a vehicle, which can be subdivided into subsystems and modules); (ii) some of the service suppliers (productive and administrative) work at the factory's facilities; (iii) in some cases, the automaker used to select two suppliers per item (but as product mix increased over the years, there were relatively fewer items with double sourcing); (iv) because the chain operates exclusively in the metal-mechanical field, it is a relatively short chain with only four levels, i.e., scrap, foundry, parts, assembly; (v) the logistics of the plant is outsourced, with an outside company carrying out its transportation activities; (vi) in the case of small volume items that come from suppliers located close to the plant, the company's logistics is based on the "milk run" system.

It is worth bearing in mind that the engine plant selected for this study currently ranks among the newly established factories, has one the widest product mixes, and is among the plants with the highest degree of outsourcing.

In 1996, the plant had approximately 60 suppliers. This number increased to around 100 suppliers of direct material in 2001, as a result of the diversification of engine models and also the product's increased percentage of component nationalization. The number of suppliers may grow even further, since the index of engine nationalization is expected to increase. There is no indication, so far, that supplier companies or units have moved to or built their plants in locations close to the engine plant.

Table 2 shows some of the characteristics of the suppliers selected for this study. This choice was based on several criteria, including their size (different sizes), the origin of their capital (national and foreign), and their supply of components with varying degrees of importance for the engine. Some of these suppliers are competitors producing the same item for the engine assembly plant.

Table 2 – *Suppliers' profiles*

Supplier	Type of company (origin of its capital)	Size (number of employees of the plant under study and of the mother company in Brazil)	Type of component supplied to the assembler	Distance from engine assembler's plant	% of production supplied to the engine assembler	Supply system
A	National	Up to 300	Castings	up to 100 km	> 50%	Milk run
B	National	From 300 to 500; More than 3000	Castings	from 200 to 400 km	< 20%	Transported by supplier
C	Multi-national	From 500 to 1000; Up to 300	Machined and assembled sub-system	from 100 to 200 km	20 to 50%	Milk run
D	National	From 300 to 500	Machined and assembled sub-system	at least 400 km	> 50%	By the engine assembler
E	Multi-national	From 500 to 1000	Machined and assembled sub-system	up to 100 km	< 20%	Milk run
F	Multi-national	From1000 to 1500	Machined components	up to 100 km	20 to 50%	Milk run
G	Multi-national	From 1000 to 1500	Machined components	from 100 to 200 km	< 20%	Milk run
H	Multi-national	From 1500 to 2000	Machined components	from 100 to 200 km	< 20%	Milk run
I	National	From 500 to 1000	Machined components	up to 200 km	< 20%	Milk run
J	Multi-national	From 100 to 300	Polymeric parts	from 200 to 400 km	< 20%	Milk run

PRODUCTION ORGANISATION STRUCTURES

This section discusses the production organisation form used by the Engine Assembly Plant (EAP) and the structures adopted by its main suppliers. The main elements of production organisation analysed herein are manufacturing strategies, technology strategies, work organisation structures, organisational structures, quality systems, logistics, and supply chain management.

The POF adopted by the Engine Assembly Plant (EAP)

We now present and discuss the EAP's functional elements and POF.

The production organization form (POF) implemented at the Engine Assembly Plant (EAP) is conditioned by a series of factors. The factors that deserve highlighting are the specific conditions of Brazil's automotive market and automotive industry, the company's overall policies (the foreign head offices and the subsidiary's headquarters in Brazil), the automaker's competitive strategy in Brazil and, particularly, the role of this strategy in the area of engines, as well as the specific conditions relating to a Greenfield plant, its location, its local policies, the technology implemented (relatively new), relations with the workers' union, etc.

The set of conditioning factors (both general and specific) makes up a unique production organization form showing similarities with structures adopted at other units of the same company in Brazil, but also possessing a considerable number of specificities.

Table 3 – *The EAP's POF*

	ENGINE ASSEMBLY PLANT (EAP)
Relationships with Suppliers	The EAP demands low prices, quality and on-time deliveries (besides, at least, production technology). In terms of new designs, whenever necessary, the EAP seeks to make the supply feasible (by triangulation, product and tooling development…). It maintains long-term relations (though not necessarily continuous commercial relations) with the suppliers it considers good, always consulting them when new items are introduced. The EAP seeks to exert its bargaining power with both small and large suppliers. It appears to have a single policy for all its suppliers (purchasing, product, process, quality and logistics audits) and does not, in principle, segment them. The suppliers make quotations and are well informed about international prices.
Type of Production Organisation	A mixture of elements of Ford-type organization processes ("accumulating"-type assembly lines) with a flexible work organization structure (cells and multitasking). Top down decision process with main weight on the first hierarchical level, with little worker autonomy in the more significant processes of change. Internal cooperation is weak. External cooperation is also generally weak but, when it is to the interest of the EAP, the suppliers (especially the smaller ones) receive support.
Main Elements	Production management (PM, Logistics and QM); middle management and supervision of production (middle management down to cell leaders); Product engineering (at head office); Manufacturing engineering (very tight structure with few people). Solutions are decided at head quarter in Brazil, with some participation from leaders. Organizational structure and information/communication system ensure alignment of the unit with the general policies and centralized decision process. Relatively up-to-date equipment (with IT) ensures monitoring of production with little need for manual collection of information.

Competitive Strategy	The company's competitive strategy is to manufacture in Brazil mainly small and medium sized passenger cars and import the more luxurious models. In the lower capacity segments, the engines are crucial competitive elements. The EAP has become the main supplier of the Mercosur countries, exporting several types of engines. The company has made investments in new plants in the last few years. Several new engine models have been introduced. The company is gaining greater capacity for the development and manufacture of engines and a certain degree of autonomy from its foreign head offices.
Production Strategy	The production strategy was initially based on cost and quality, but then passed on to cost, quality and flexibility with the introduction of new types of engines. Because the unit already operated with a high level of outsourcing, in addition to structural changes for the production of new models, it had to reinforce its supply management, since the chain has become more complex (more items and more suppliers). The infrastructure areas had already been designed to support greater flexibility. A further pressure on the production strategy is the need to increase the level of engine nationalization.
Technology Strategy	The company is supported, in terms of design, by its foreign head office and has been increasing its competence in the development of engines in Brazil. It has adopted the engineering structure (product, process and manufacturing) that ensures returns on its knowledge in manufacturing engineering (of which there is only one functional unit in the EAP) accumulated by the plant.
Organisational Structure	In line with a flat structure (4 hierarchical levels), qualified at the upper levels. Workers with high level of schooling (secondary). Structure and information/communication system ensure alignment with top management decisions. Communication system filters decisions from top management down to shop floor level.
Production Mgmt	Relatively simple internal production management, since engine assembly is an intermediary process that is dependent on the number of automobiles to be produced. Efforts, therefore, focus on Logistics (a fact that is reflected in the unit's administrative structure).
Quality Mgmt.	Follows the headquarters regulations and has a relatively modern corporate quality system. Much value is placed on quality control. Improvement programs are conducted by the company, which hold ISO 9000 (corporate) and ISO 14000 certification.
Work Organisation	Relatively low salaries, little active local workers' union, a stagnant job market, relatively good work conditions. The work is organised in cells, communication is easy and worker involvement is a requisite. A Factory Commission was established and the EAP's workers and those of the Brazilian head quarter's plant got together, but so far workers' claim movements have been restricted to salary issues.
Logistics	Logistics are managed by the plant but are outsourced. The JIT milk run is used whenever possible. The EAP recently showed concern regarding the cost of logistics: it is now reassessing the system. The systems are designed to allow for fast response (daily) to unforeseen events in the industrial chain.
Supplies	Purchasing is centralized at headquarters and is based on evaluations involving pricing, quality, engineering (for new or modified items) and logistics. Depending on the value of a purchase, the final decision is made at the company's foreign head office. There is a single policy (no segmentation) and periodic (audits) and ongoing evaluations (at receiving) ensure supplier alignment.

Relations with Unions	There has been a certain degree of closeness between the workers of the EAP and the company's main plant in Brazil, with some "contagion" between workers and administration and between the unit and the union. Claims today are articulated and synchronised. A factory commission was established. However, the local union is weak.
Additional Information	The EAP's production organization was initially and unconsciously designed for a greater potential for flexibility than required. It consists of a combination of assembly line, Fordism, concern focused on production costs and cells, multitasking. The organizational structure and information/communication system are appropriate for the company's policies and decision-making process. There was a change of managers when the plant passed on from the implementation to the consolidation phase. Environmental concerns affect even its logistics.
Result	The result is a mixture of haste (to get the plant ready); consolidated policies; new location and conditions (workers' union, environment, workers...); and testing of innovations (outsourcing, milk run,…).

Role in the Competitive Strategy

The company under study had to establish a new engine plant (for the manufacture of low capacity engines) in a short period of time, which caused significant impacts on the design of the factory and on the level of outsourcing that was chosen. It should be noted that, since its establishment, the [government's] exchange rate policy has favoured the expansion of the level of engine nationalization.

Thus, the plant that was hastily established to fill the most visible gap in the segment of 1.0-litre engines soon thereafter became the focus of new investments and alterations to house the production of several types of engines. These investments themselves are proof that the EAP has fulfilled the role it had been given by the automaker.

Another aspect that must also be considered is that the production scales of this company's engines are relatively high in the domestic market, which justifies its position of prioritising the reduction of production costs. In other words, the company is part of an industrial segment classified as a differentiated and concentrated oligopoly, which, therefore, in addition to its concern with differentiated products (in terms of quality, aesthetic design, maintenance, comfort, fuel consumption, power/speed, etc.), prioritises cost reduction.

Hence, the EAP's POF has to allow for:

- ✓ relatively low costs;
- ✓ good technical production performance (quality, lead time, productivity, use of installed capacity, low stocks, on-time deliveries, flexibility, services), in short, all the competitive production priorities must be achieved efficiently;
- ✓ proper flow of information about technology, management policies and performance so as to ensure continuing technological improvements, the proper use of company policies and control of the plant's performance from the various standpoints of evaluation;
- ✓ experimentation of aspects, methods and techniques not yet implemented at other units of the company.

How does the POF make these possible?

- ✓ Basically through an efficient operation (low operational cost), which is achieved by means of several factors and some steps taken by the company: relatively cheap labour, with the cost of capacity fluctuation also balanced (number of shifts, hour bank, hiring and firing costs); equipment partially low cost (some items have been retrofitted); "lean" operation (little stock); supplier chain close by and pressure on component costs.
- ✓ Production and quality management are essential for the maintenance and improvement of the performance levels. This management, which also includes Human Resources (HR), is done in such a way as to ensure the implementation of the company's general policies, using relatively modern resources and ensuring a certain level of centralization (subordinating the measures taken at the plant to the policies defined by the Brazilian headquarters, while simultaneously using mechanisms such as cells and the diffusion of information to engage worker participation on the shop floor). It should be noted that the middle management plays a fundamental role in ensuring an efficient operation, guaranteeing the implementation of centralized policies and solving the everyday problems (with some support from the workers, albeit still rather limited). This management extends to the suppliers and in some cases

even to the suppliers of the suppliers (with the purchase of components by the automaker, which are then consigned to suppliers) and is linked to the management of the client units.

- ✓ The flow of information of several types is essential for the plant's operation and is ensured by means of (a) information technology, (b) daily (and easy) communications between functional units, (c) communication with and high bargaining power over suppliers, (d) an ingenious organizational structure.
    - The information and communication technology allows for easy contact inside the plant, with the Brazilian headquarters, and with the company's "client" units. Moreover, the computer network combined with internal manufacturing and transportation equipment with flexible automation allows for the automatic collection of production process events relating to each piece of equipment and every engine (the plate on the engine's pallet).
    - The plant's executives make long-term decisions, but also hold daily meetings to take corrective actions based on events that have occurred at the client units, suppliers and in the plant itself.
    - There is an agreement with the suppliers that the EAP can modify its orders on a daily basis (within the scheme the EAP calls JIT [just in time]).
    - The organizational structure is composed of units functionally subordinated to the plant's management (production, logistics and engineering) and by units that report to the manager, but are functionally connected to the headquarters in Brazil (quality and human resources), in addition to having centralized functions such as purchasing and costs. In every case, communication is horizontal and easy, functional communication is ensured and occurs frequently, besides the predefined processes and meetings attended by people from different units (such as the executive forums, the quality weeks, and the selection and evaluation of suppliers).

- ✓ Several kinds of experiments have been made at the EAP, distinguishing the plant from the company's other units: a secondary education as the minimum hiring level, a different type of industrial relations, high outsourced employee participation at the plant – albeit not in direct productive activities (movement, tool shop), outsourcing of administrative services such as HR; the use of a standard uniform (including executives), a single restaurant for all, open offices with few dividing walls, a "clean" factory, milk run logistics. Few of these experiments, however, have a central importance in the characterization of the production organization form adopted.

What is the importance of the supplier network?

It should be pointed out that relations with suppliers have become one of the sustaining pillars of the plant's performance, even more so after the Real (Brazil's currency) was devalued.

This situation, then – an organization with a high level of outsourcing, with a chain of suppliers dominated by the EAP – has apparently become convenient and produced positive results for the company.

The type of relation the EAP seeks with its suppliers results from its objective of reaching low production costs and its technological capacity in essentially metal-mechanical processes. This situation leads to the EAP's attempts to dominate its suppliers, its search for two suppliers per item (whenever possible and feasible), and the non-establishment of partnership relations within the moulds that would be indicated by the lean production model.

Thus, the EAP's production organization consists, initially, of the automaker's policies aimed at cost reduction (purchasing, suppliers, production and quality management, manufacturing cells…), relatively cheap labour with no workers' union experience but with a high educational level, relatively modern and automated equipment in a clean factory, in addition to the new experiences mentioned earlier, such as the milk run and outsourced operations and services. All this combined in an organizational structure that ensures articulation and integration with the subsidiary's headquarters in Brazil.

The fierce competition in the low-powered passenger car segment and the introduction of middle sized cars with higher powered engines, allied to the good performance of the new engine plant, created the need for a diversification in the mix of engines. As new engines are introduced, this is going cause successive alterations to be made at the EAP's two plants to incorporate new operations or new production lines. The plant apparently shows a high performance not only in comparison to the automaker's other older unit in Brazil but also to other manufacturing units abroad.

It should also be mentioned that competition has become intense in a stagnant market (the Mercosur). Therefore, this means that a greater variety of engines in smaller quantities must be produced. In other words, the EAP (and its supplier chain) is changing as it undergoes greater pressure to increase its flexibility.

This pressure causes impacts, such as the modification of the supply chain. Changes in the production organization form were (and still are) subtler and originate from a more varied mix of products and a production strategy in which flexibility has become a priority. To a certain extent, the EAP's plant had adopted a flexible organizational structure (at least from some standpoints), but at the beginning its process more closely resembled that of a mass production line. Now it will have to prove that its organizational structure, which was designed for flexibility, is indeed flexible.

Another element of change to be considered was the getting together of the workers from the company's main Brazilian unit with those of the EAP. This means that, even with a local union that is little active and despite the differences in educational and salary profiles, the EAP's workers tend to organize similarly to the way the workers at the company's older units do and to engage in articulated movements to claim workers' rights.

One must also consider that, this being a relatively new plant that has experienced a series of changes and adaptations, the decision-making pattern is predominantly from the top down, with the responsibility for successes and failures resting on the top hierarchical level of the organizational structure. The result of this is that, similarly to the external relations with

suppliers, the internal relations between management and labour are predominantly those of "command", with timid initiatives to better explore the workers' knowledge potential.

The EAP's POF has, therefore, evolved incrementally, with its functional elements adapting mutually from the initial structure, whose flexibility was greater than necessary for the production system, to another (different in but a very few aspects), in which the structure's flexibility must prove appropriate for the required (necessary) flexibility of the production system. However, from the beginning up to the present, the production organization form has not been "designed" by the company and is characterized as something intermediary between a Ford-type organization (seeking scale and cost reduction) and a flexible organization (lean) (that seeks scope economies within an environment of external and internal cooperation).

The production organization in the supply chain

In this item we analyse the production organization forms of the suppliers surveyed for this study from the standpoint of their functional elements. Tables 4 to 6 systematise the analysis of the data of three companies selected among the 10 companies surveyed. Similar tables were drawn up for all the companies, but we have chosen to illustrate only the analysis made for three cases showing significantly different POFs.

Table 4 – *Analysis of the production organisation of Company E*

Relationship with the Automaker	The company meets the automakers' requirements and demands, but its relationship with them appears to be one of peers. The EAP's bargaining power with regard to technology (T), quality (Q) and logistics (L), therefore, does not appear to be much greater than its own.
Main Elements	Production management and Quality management; qualified part of production (before assembly, whose work is less qualified); Product engineering (at headquarters); Relatively sophisticated manufacturing technology; Relations with clients. Solutions are its own and engineering, with little shop floor worker participation.
Competitive Strategy	60% of sales are for the replacement market. Its acquisition by a larger company from the electronic sector strengthened its trade name and distribution channels. The factory also began producing parts for heavy vehicles.
Production Strategy	It adopts production management and quality management techniques. The size of production lots and the level of stocks have been reduced.

Technology Strategy	The company develops its products at its foreign headquarters.
Organizational Structure	Flattened structure.
Production Management	It has begun adopting lean production practices.
Quality Management	Up-to-date systems and techniques, performance according to standards, and high performance.
Work Organization	Relatively low salaries, workers with good schooling and technical education, facilitating the use of techniques (MASP, 5 steps, poka yoke), but very young, which has created turnover-related problems.
Logistics	Company does whatever the client requests, but has to maintain stocks (2,5 day stocks in the case of the EAP).
Supplies	Suppliers not very close. The suppliers located closer are not used owing to the need for technology (more automation, castings with higher precision and quality) and production volume. The company was verticalised but now outsources several items (springs, forged parts, studded and riveted stamped parts, tool shop, mould building). It is implementing long term relationships with some of its suppliers.
Relations with Unions	Need to negotiate with an active workers' union.
Other Information	Plant designed for a maximum of 300 employees, based on the idea of a focused plant.

Table 5 - *Analysis of the production organisation of Company A*

Relations with the automaker	The EAP's influence is extremely strong and much of the company's recent success has resulted from its meeting the EAP's requirements. The EAP stipulates what is to be done, in some cases monitors the implementation of a change, and even has access to the supplier's cost sheets.
Principal Elements	Its POF follows the "Fordist-Taylorist" style: little process automation, many individual workstations, and payment per production. The main managerial elements are: production management (PM) and quality management (QM); Product/process/manufacturing engineering (with a high level of interference from the EAP); Relations with customers (to meet their demands). The solutions are provided by the EAP (for which reason there are solutions found at the EAP adapted to the company's conditions), with no structure for worker participation.
Competitive Strategy	The company has linked its fate to that of the EAP and produces outsourced parts in order, on the one hand, to ensure flexibility and cost reduction and, on the other, to integrate a process with higher added value.

	All its efforts focus on meeting the EAP's requirements.
Production Strategy	The foundry structure is traditional (unsophisticated) and cheap. The competitive priorities are determined by the EAP and the company's infrastructure areas are little qualified, but are supported (monitored) by the EAP.
Technology Strategy	The product fully meets EAP's requirements and the company's production process competence is ensured by a managing engineer and support from the EAP.
Organizational Structure	The structure is compatible with the company's size, little qualified and highly centralized.
Production Management	Cheap labour and outsourcing ensure low costs and the possibility of forming finished goods stocks (required by the EAP).
Quality Management	A recent effort focusing on qualification relates to the improvement of quality levels and standardization. Partnerships established with a mould manufacturer and with a university (laboratories). Samples are working as at the EAP.
Work Organization	Relatively low salaries, almost inactive workers' union, market retraction; part of the semi-qualified work ensures involvement and low labour-related costs, even with oscillating workload. Outsourcing of some production sectors, e.g., deburring.
Logistics	Produces according to customer orders: lot sizes and finished item stocks.
Supplies	Mainly raw materials for foundry; no problems reported.
Relations with Unions	These do not affect the company but also do not promote more modern relations.
Other Information and Comments	The company's survival depends on its subordination to the EAP, but this survival is also to the EAP's interest (the product is exactly like EAP wants it; total control of the EAP, even over costs). The structure works with a management that is not highly qualified (and is cheap), but capable of meeting the EAP's demands.

Table 6 - *Analysis of the production organisation of Company D*

Relations with the automaker	The company supplies the EAP with machining and assembly services. The EAP's influence is total, and much of its relative and recent success depended on meeting the EAP's demands. The EAP indicates what has to be done, in some cases monitors the implementation of a change, and even has access to the supplier's cost structure. It should be noted that the company had to wait for some time before its demands were met. The selection of this company apparently was not done with the care that the outsourcing of an important production process requires. The company has done, and still does, everything the EAP demands.
Principal Elements	The company's process involves modern equipment, cell-type layout and an organizational structure similar to that of the EAP, though less sophisticated. Its main production management elements: production management (PM) and quality management (QM); the most highly qualified part of production are its machining services; Process engineering (to meet the customers' product specifications); Manufacturing technology (machining centres); customer relations. Solutions are dictated by the EAP (which is why it tends to organise similarly to the EAP), without an organisational structure for worker participation.
Competitive Strategy	The company has a family structure and is dependent on the EAP. However, its production process is relatively complex. Its survival depends on the EAP. To ensure its business means to produce with the quality and at the cost demanded by the customer.
Production Strategy	Sophisticated and expensive structure, which was guaranteed by the EAP. The company now has to operate it properly. High quality (Q) and low cost (C). Its infrastructure areas were also strongly influenced by the EAP.
Technology Strategy	The product's design is the EAP's property, and the latter also aids in the supplier's process development.
Organizational Structure	Structure compatible with the company's size, tending to become more professional.
Production Management	Relatively simple; meets the EAP's scheduling.
Quality Management	Defined by the EAP. The quality manager was nominated by the EAP; quality practices are up-to-date. Recent efforts toward standardization have been made.
Work Organization	Qualified labour, which does not translate into high salaries or into greater workers' union action in this region. Most of the problems are solved by management (with EAP support) and without worker participation.
Logistics	Scheduling and logistics follow the dictates of the EAP.
Supplies	The EAP purchases and delivers the components.
Relations with Unions	Do not affect the company but also do not promote more modern, participative relations.

Other Information and Comments	The company provides machining and assembly services for the EAP. Its survival depends on its subordination to the EAP, but its survival is also to the interest of the EAP (the product is exactly as dictated by the EAP, which exerts a strong control, even over costs). To function properly, the structure requires a more highly qualified management, but is supported by relatively qualified and cheap labour. This structure would appear to work better within a modular consortium.

An analysis of the data regarding the production organisation structures of the 11 companies led to their classification as shown below.

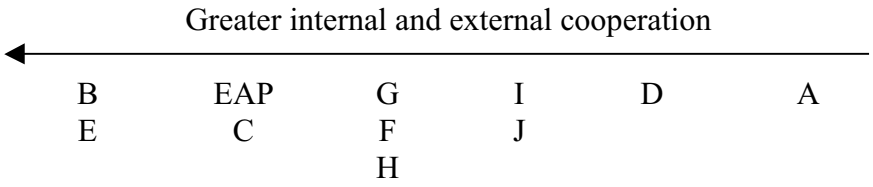

Figure 1 – Companies' positions in a spectrum of cooperation

Figure 1 shows the relative positions of companies, including the EAP, in a spectrum of degree of internal and external cooperation as evaluated in this piece of research. Internal cooperation refers to the degree of involvement and autonomy of workers in the companies' improvement programmes. External cooperation refers to the degree of long term relationships between companies and their suppliers and clietns.

Some characteristics of suppliers' POFs and of relationships with the EAP

To simplify our discussion of the characteristics of some functional elements, it should be kept in mind that supplier behaviour varies according to the origin of the company's capital, the industrial and market segments in which the supplier operates (exclusively, or not, in the automotive market), its size, technological capacity, proprietary technology, etc. The suppliers surveyed here can be classified into two categories: (1) large, multinational, with strong technological capacity, and (2) small, with national capital and relatively lower technological capacity. There is also the case of Company B, which could constitute a third category, since it is large, has strong technological capacity (like the companies in the first group), but the origin of its capital is national (as in the case of the second category).

Tables in the Appendix provide an idea of how these groups of companies organize some of their functional elements, indicating, for each element, the "pivots" at which major variations occurred in the sampling of the supplier companies surveyed here. This may be useful since it illustrates the dimensions in which the POFs vary and also how the functional elements vary.

We will now examine in greater detail just two of the functional elements we consider the most important in the conformation of the companies' POFs: production strategy and work organization. Similar analyses were made for the other elements mentioned herein, but this article lacks the space to present them.

Production strategy

The production strategy causes the companies' competitive strategies to unfold into production changes and practices. The production strategies of both the EAP and its suppliers are conditioned by market fluctuations and by the automaker's product launch strategies. The dimensions of cost and quality conformance are constant priorities (moving targets) at each company.

Table 7 – *EAP and supplier manufacturing priorities and main action plans*

Suppliers	Manufacturing priorities	Main action plans
EAP	C, Q, F	Q certifications, scrap and rework reduction, audit and development of suppliers, reduction of technical assistance services, and continuous improvement costs
A	Q, C, D	Certifications, scrap reduction, buffer stock for ready delivery, cost reduction programs
B	C, Q, S	Conformation to quality, raw material costs, reduction of buffer stocks and incremented productivity
C	Q, C, D	QFD and SPC, certifications, supply chain (development of suppliers), cost reduction of raw materials and overhead, reduction of set-ups
D	Q, C, D	Certifications and parts audits, product design and process improvements, PCP programs
E	Q, C, F, D	Reduction of bottlenecks and of set-ups, kaizen, production cells, certifications, conformation to quality
F	C, D, Q	Segmentation of processes into small lines (mini manufacturing units), lean manufacturing, new equipment, reduction of lead times and of scrap
G	C, Q, D	ABC cost control system, new production process, worker multitasking/multi-skills, product development, reduction of lead times, incremented productivity
H	C, D	Statistical process control, MRP, operational training, increased productivity, reduction of lead times
I	D, F, Q	Implementation of manufacturing cells, theory of restrictions, workers' multitasking/multi-skills, quality certifications
J	Q, F	Production control using bar codes

Legend: Q – quality, C – cost, D – deliveries, F – flexibility

An analysis of Table 7 shows that the EAP's priorities are Q, C and F and that most of the suppliers' priority dimensions include Cost reduction, conformance to Quality, and on-time Deliveries of ordered quantities. These dimensions may be considered basic (qualifying) requisites that all suppliers should meet, but they are also reinforced by market conditions and by the EAP's specific strategy.

Flexibility is an important dimension in some cases and will tend to be emphasized in the supply chain as the EAP's flexibility increases. The EAP has significantly expanded its production line along its five years of existence, but some suppliers have chosen to keep their stocks of finished goods, which enable them to fill orders promptly, rather than to increase their production flexibility. The EAP also demands flexibility (of production volume) because it confirms its orders only one day ahead of their production. Flexibility is also a tendency owing to the market fluctuations and the intensification of new product launches. The chain's structure has changed as a result of the greater number of suppliers and items supplied.

In addition to this type of need, which is reflected in the EAP's requirements, flexibility may also be a priority for some suppliers as a result of their own policy or the production organization model they use as a reference. This influence factor is present in the two cases of suppliers (in the sample) that prioritise flexibility.

It is clear that the EAP's demands, which are expressed in several ways (e.g., audits and recommendations), and its production strategy, (PS), condition the suppliers' PSs. This influence is greater the lower the supplier's technological capacity, the smaller his size, the greater the percentage of his production volume destined to the EAP, and the greater the degree of "partnership" between them (or the greater the risks they share).

Small suppliers with national capital (such as companies A, D and I), in particular, are obliged to accept the EAP's recommendations. The EAP's influence at these suppliers is very strong, but much of the success of these suppliers depends on meeting the EAP's demands. The

EAP indicates what has to be done, in certain cases monitors the implementation of changes, and even has access to the supplier's cost structure.

In contrast, in the case of larger suppliers, which usually supply several automakers, their strategies must generally be compatible with their customers' demands, but their power of self-determination is considerably greater. In these cases, the emphasis on quality or flexibility, for instance, depends more on how the companies see the market and their own medium/long-term competencies and also on how much they have incorporated the flexible production model.

The technology and quality of this group of companies are recognized in the market. Their strategies and production organization forms are influenced by factors that condition the sector as a whole, through the diffusion of the models, and there is no evidence of any specific and strong conditioning from the EAP or any other automaker.

The main production priorities of these companies are quality and/or cost, followed by deliveries and flexibility. They also place great importance on quality improvements at their suppliers but only a few of them develop joint [quality] programs with their suppliers.

With regard to Cost, the companies have implemented programs to reduce their production costs. They have also reduced the cost of materials, overhead, lowered their break-even points, sought to maximize their cash flow, and implemented ABC Cost Control, monitoring the factory's productivity levels.

As for Deliveries and Flexibility, the companies have reduced the production time, the set-up time, and implemented JIT/Kanban systems. In general, the average size of the production lot has also been reduced substantially. Some of them have implemented Flexible Manufacturing Systems and flexible cell layouts.

Some of these companies have adopted worker rotation among workstations, aiming to also flexibilise the use of labour; they invest in training programs in the various quality tools, seek greater employee involvement in quality and employee participation (through the Kaizen

program) in ongoing improvements of products and processes, thereby contributing toward a reduction of scrap and rework and, hence, toward an overall reduction of costs.

Company B, a large company backed by national capital, meets the automakers' requirements and demands but appears to deal with them on an equal footing. Unlike the other national suppliers surveyed for this study, the changes in its strategy are not directly related to its supply to the EAP. This company defines its strategic efforts autonomously, displaying a behaviour similar to some of the multinationals sampled here.

It is clear that, through either direct or indirect mechanisms, the EAP's PS is a strong conditioner of the supplier's production strategies, and is virtually the determining factor in the case of the smaller companies surveyed.

It is also evident that, depending on the company's recent situation (especially in the case of some of the smaller ones) and on the need to achieve urgent results in several areas, the set of programs implemented may be of a considerable scope, requiring efforts and competencies that these companies do not normally have at their disposal. Be that as it may, it should be emphasized that, according to the interviewees from most of the companies (large and small) and according to EAP's assessment, the results achieved by the suppliers have been highly rewarding.

The main axes of variation of the Production Strategy element in the sampling of the companies studied here are, thus, the intensity with which the dimension of production flexibility is prioritises and the extent to which the production flexibilisation programs are implemented. All the companies consider the dimensions of Quality (conformance) and Cost reduction important. As we have seen, the EAP's production strategy influences the suppliers' production strategies, particularly the smaller ones and those with less technological capacity.

Work organization, organizational structure and industrial relations

As can be seen in Table 8, the work organisation structures at the companies studied here are heterogeneous, although in a good many cases the cell manufacturing structure is employed. Even in the cases where there is job rotation, the tasks are repetitive and the cycle is relatively

short. A certain amount of employee participation is also found, in the sense that they identify with the company and assume its policies.

Table 8 – *Work organisation at the EAP and at its suppliers*

	Basic work organisation structure	Minimum level of formal education	Required attitude and qualification programme	Kaizen type of programme and worker autonomy
EAP	Cells with 11 workers (internal maintenance)	Secondary	Involvement and multi-tasking; intensive training	Cells are responsible for improvements, with some autonomy assigned to workers (mainly to solve problems)
A	Individual stations	No minimum	No established requisites	No programme
B	Cells (mini-factories), work teams	Primary SENAI (technical school)	Involvement and multi-tasking; intensive training	Innovation programme with high degree of worker autonomy
C	Cells	Secondary	Involvement and multi-tasking; intensive training	Improvement programme with teams of workers
D	Cells (mini-factories)	Primary	Training programme	No programme
E	Cells	Primary	Involvement and multi-tasking; intensive training	Improvement programme (SPC), cross-functional teams
F	Cells (mini-factories)	Primary	Involvement, teams; intensive training	Improvement programme
G	Cells	Primary	Involvement, training programs	Improvement programme defined and controlled by management
H	Cells in the machining sector	Secondary	Intensive training	Improvement programme with teams of workers
I	Cells	Primary	Training programmes	No programme
J	Production lines and cells	Primary	Training programmes	Beginning Kaizen and group programmes

Although there are significant differences within each group of companies, it can be stated that the group of large companies and multinationals has been using its current organizational practices for a longer time, while the productive restructuring process was initiated more recently in the group of smaller national companies and has been conducted at a slower pace. In the second group, the contact with large client companies and, in most cases, the pressure exerted by the latter, have been the main motivating factor for the implementation of these restructuring processes.

With the exception of Company A, the others organize at least part of their production into cells and expect their workers to be capable of working at all the workstations of their respective cells. The cells operate by a system of rotation, with the exception of Company G. The interviewees of companies A, B, D and E mentioned that the work rotation is based on information made available through a system resembling the versatility work chart used at the EAP.

Despite the practice of rotation, the fixed workstation of reference still appears to be predominant. Work in the cells tends to resemble what Salerno (1999) and Marx (1997) define as "enriched group".

In addition to this "horizontal enrichment", the companies also seek "vertical enrichment", with the employees carrying out quality control activities, some kinds of corrective and preventive maintenance, cleaning and a variety of annotations. All the companies in the multinational group stated that their workers are multi-functional, although it is difficult to assess the extent to which this concept is applicable simply through interviews with the managers.

What is evident is at least the declared intention of this group of companies to have workers who can solve everyday production problems. The reduction of hierarchical levels is another effort in that direction.

Another indicator of this intention is that, with the exception of Companies I and A, all have sought to intensify the practice of operational worker participation and involvement, mentioning the existence of formal programs (improvement teams, Kaisen, suggestion boxes) to implement them. Despite these programs, however, worker autonomy is restricted to solving everyday problems.

To intensify participation, the directors and managers interviewed, both those connected to production and to human resources management, claim they are investing in technical and behavioural training, especially in groups, and in problem solving. Several companies have invested in formal education complementary programs, especially primary schooling (some also include the workers' families).

Whenever the region where they are located permits, the companies have given preference to hiring workers or trainees from primary and secondary trade schools such as SENAI. It can be

stated that the level of formal schooling in the first group of companies has increased. The companies of the second group share this concern, but are not always so successful.

In addition to the salary differences between the automakers, the large autoparts companies and the smaller companies, there is also a clear difference among the plants of the same company, according to their location. Those located outside the greater São Paulo region pay lower salaries. Thus, one can see that, besides the company's size, its geographical location also influences the salary levels.

Another factor with a strong regional influence is the relations with labour unions. The behaviour of the labour unions of the companies surveyed was found to be quite heterogeneous. One point that stood out in the interviews was that the prospect of establishing new plants outside the traditional region (and the effect establishment of several) alters the bargaining power of the workers in the traditional region, a fact that was also observed by Kädtler and Sperling (2001).

There is a general trend in regard to work organization; however, the suppliers' strategies, their human resources policies, the situation of the work market and the relative power of the labour unions dictate the pace of changes in this area.

The EAP does not make any direct demand on its suppliers regarding practices in these areas. Its influence, in this case, is indirect. But because the production strategies are influenced by the EAP's strategy, the latter exerts an indirect influence on the suppliers' work organization structures. By demanding ISO 9000 certification, for instance, the EAP also imposes the need for formal monitoring at the suppliers' of the evolution of their employees' skills; and by demanding delivery flexibility, it imposes the need for workers capable of facing production fluctuations and the problems deriving therefrom.

In addition to the above, however, the EAP's organization structure is a strong reference for the suppliers, particularly for the companies of the second group. This was clearly illustrated, for instance, in the case of the work versatility chart that Company E has attempted to adopt.

As we saw in the case of work organisation, companies have adopted production cells, but even where job rotation is a routine practice, the tasks are repetitive and have a relatively short cycle. Although there are initiatives aimed at worker involvement, worker autonomy remains limited. With regard to this functional element, the EAP's strategy has had an indirect impact on

the suppliers' work organisation, although the work market and local labour unions appear to exert a stronger influence.

The principal axes of variation in the sample of the companies surveyed are the organizations' experience in the use of modern practices (cells, rotation, vertical enrichment), qualification and worker participation/autonomy in improvement programs.

POFS IN THE CHAIN OF EAP ENGINES - SUMMARIZED

Before presenting our conclusions regarding the POFs of the companies belonging to the same supply chain, it should be noted that these POFs and the relations between the companies are affected, among other factors, by the general market conditioning factors, the industry and Brazilian legislation, by automaker and supplier strategies, by the specific strategies of the units analysed within the same supply chain, and by this chain's configuration. In the case of the EAP, as we have seen, its supply chain is marked by a high degree of outsourcing, and a lesser degree of cooperation with suppliers (in comparison with the other engine assembly plants established in Brazil), and by the production of a relatively large mix of products, which is expanding with time.

It is also interesting to note that the nature of the relations can change along time according to the role of the supplier and of the component he produces for the EAP. Basically, there is the situation in which the EAP seeks a supplier for a "new" item, which requires what the sector calls "supplier development". This is the moment when the EAP requires a new component, with specifications that do not exist in the market, either because it has developed a new product design or because it wishes to outsource (begin purchasing) a component or a stage of production (manufacturing service) it has previously executed itself. At this time, the EAP has a strong interest in "finding" a supplier that can quickly meet its needs.

In another situation, which characterises another type of automaker-supplier relationship, an item or component is easily found in the market because there already are suppliers with all the conditions required to produce it. In this case, the automaker's efforts directed at the component and everything relative to the respective supplier is not so vigorous.

In our study of the EAP's relationships with some of its suppliers, we found these situations conditioning its relations with both the types of suppliers mentioned. The EAP's relations with the multinational supplier group are characterized by a similar bargaining power, in which the exchange of information and the agreements established cannot be classified as unbalanced. Even so, it should be mentioned that these large suppliers have to meet the requirements of several automakers, which dominate the design (or the architecture) of the product.

The EAP's relations with the second type of supplier are significantly different in the two above-mentioned situations. In the first, the EAP usually has to make a relatively strong effort to capacitate the supplier to supply the desired item or service. In the second situation, the EAP's efforts directed at the suppliers are substantially less, depending on the results of the evaluations when the lots are received and the periodic audits are performed. In both situations, and owing to the characteristics of the second type of supplier, the EAP's influence and control over the supplier's actions are very strong. As reported previously (ALVES Fo. et al., 2000), the degree of automaker control over suppliers is greater the lesser the latter's technological capacity, the smaller the supplier, and the greater the proportion of their production destined to the automaker.

In short, the EAP's POF is characterised by its main core, which is located in the top hierarchical levels (including middle management), and is the element that simultaneously ensures the implementation of the company's overall policies, articulates the unit to company's other productive units (vehicle manufacturing units) and to the functional administrative areas (quality, human resources) and the technical areas (product and process development), manages and controls supplier behaviour from several standpoints, and ensures the performance of the productive process itself. The various functional elements, such as the organisational structure, the system of information and production process automation, work organisation, JIT/milk run logistics, etc., are also articulated to support this nucleus, which sometimes incorporates the more highly qualified shop floor workers.

Through this production organisation form, the EAP achieves relatively low costs; satisfactory technical production performance; an adequate flow of information about technology

and performance management; and experiments with practices not implemented in other units of the company.

The suppliers' production organisation structures (POFs) were found to be heterogeneous. It was found that: (1) the ten companies use POFs that differ from one another. (2) Their POFs differ from that of the EAP. (3) The different structures, placed in a spectrum, would show the flexible production model at one end and the mass production (or Taylorist-Fordist) model at the other. None of the ten companies is positioned at either end of the spectrum. (4) The multinational and large companies have organisational structures similar (though not identical) to that of the EAP. (5) The small national companies are positioned nearer the right-hand side of the spectrum, close to the Taylorist-Fordist end (in relation to the positions of the multinationals). (6) The companies with the highest levels of internal and external cooperation (although the latter depends on the willingness of its automaker clients) are the only large company with national capital (B) and one of the multinationals (E).

In addition to these findings, we found that, in general, and as in the case of the EAP, the suppliers' POFs are supported by the nucleus formed by the middle management and engineering staff, and the forms of cooperation, both with customers (and specifically with the EAP) and with suppliers, are also limited. We also found that, upon setting up their POFs, these companies combine relatively simple and unsophisticated functional elements with others that are sometimes complex and require more sophisticated techniques. However, the choice falls preferentially on a combination of production process structures specialized by customer or divided into dedicated manufacturing cells, automated/computerized production and quality control systems, a simple form of production management (according to the structure defined), quality management that meets a set of standards, production and technology strategies with emphasis on cost reduction and conformation to quality, and a work organization that values employee involvement, albeit with little autonomy or participation in improvement processes.

Summing up, although each POF can be considered unique, companies adopt similar organizational structures according to the origin of their capital, their size and their technological capacities. Multinationals and large companies are autonomous in the definition of their

organisational characteristics, while national and small companies are strongly influenced by the EAP. There is a tendency for greater internal and external cooperation, but it is still only tentative even in the group of multinational companies.

This vision of what is predominant and of the power of the EAP's influence should not, however, obscure the variety of forms that were found. In each company, for different reasons, functional elements have specific characteristics, are mutually conditioned, and are combined in a given manner. They must be compatible both internally (within the POF) and externally (with the EAP's POF).

As indicated by the axes of variation of the functional elements proposed herein, there is, in principle, a wide space for the definition of each functional element and for compatibility to be achieved among the various elements that make up each company's Production Organisation Form (POF). However, both the multinationals and the domestic companies have chosen and adopted fairly traditional organisational structures (with the use of some modern techniques), which are centred on the competencies of the executives and technical staff of these organisations' top hierarchical levels, minimising the need for internal (administration-shop floor) and external (EAP-supplier) cooperation. The EAP's support of smaller domestic companies is based on its interest in the component's nationalisation or its outsourcing rather than on a supplier development policy.

A more detailed analysis of the production organisation structures adopted by the companies selected for this study and the EAP-Supplier relationships (including the relations among functional elements) could also provide results equally relevant as the ones mentioned herein and, thus, further justify the approach adopted for this research. A continued and detailed study of functional elements, without losing sight of their relationship with the companies' strategic decisions – which are related in supply chains – may also lead to palpable findings in the study of production organisation models.

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APPENDIX A – OTHER FUNCTIONAL ELEMENTS

Technological Strategies	
General characteristics	They articulate the company's technological capacities (of the headquarters, in some cases) to the capacities of the unit studied. The companies must have at least a minimum manufacturing capacity, but the product and process development capacities vary greatly in the sample.
Group of multinationals	All have strong technological capacity in design and manufacturing, but only a few have local (decentralised) design.
Group of national companies	At a considerable number of the small national companies, the EAP has to support or even demand product and process development, particularly when the component of subset is outsourced or has a new design, for which there is no available supplier in the market.
Axes of variation	The main axes of variation here involve the extent to which the capacities of design, process development and manufacturing method development are decentralised (at the productive unit or in Brazil) and are distributed/shared within the organisational structure.
Relations with the EAP	Because the EAP's design capacity in Brazil is relatively well developed, the company tends to demand a similar performance from its suppliers. In the case of relations with companies of national capital, this implies efforts on the part of the EAP for development in the areas of product and process development of these suppliers.

Organisational Structures	
General characteristics	Generally tend to be flattened, with the decision core in the top hierarchical levels and with little worker participation in everyday production-related decisions. The internal information and communication systems, increasingly computerised, support this type of structure. Data collection about production and quality is done automatically at some of the suppliers by transport machines and equipment.
Group of multinationals	Their structures have been reformulated for longer; they are consolidated and complex owing to these companies' size and involve relations with headquarters in Brazil or abroad.
Group of national companies	Slim, simple structures with few hierarchical levels, with a movement toward specialization (as these organisations become more professional).
Axes of variation	The main axis of variation here is the extent of horizontal and diagonal communication (outside the lines of subordination).
Relations with the EAP	The EAP has a modern organisational structure well designed to meet its needs for frequent communication with headquarters in Brazil. The EAP's communication channels with its suppliers are well established and multifunctional.

Logistics, PCP and Supply Systems	
General characteristics	Production systems tend to specialised by customer. At many of the suppliers studied the PCP systems are very simple because the production structure (assembly lines or manufacturing cells) is specialised by (or dedicated to) the EAP. New logistics systems have been implemented and are completely under the EAP's control, but the suppliers adapt to the new demands in various ways.
Group of multinationals	These have specialised production structures (usually manufacturing cells by client) that are well developed and backward verticalised. However, only a few of them attempt to work with the external JIT system (both with suppliers and clients) so some of them end up maintaining relatively high stocks of finished products for prompt deliveries to customers.
Group of national companies	These also tend to have specialised structures, but have to meet the impositions of suppliers and customers.
Axes of variation	The axis of variation here is the extent to which the supplier works with relatively small production lots (under the JIT system).
Relations with the EAP	The EAP determines the size and frequency of delivery lots and type of logistics (direct deliveries or milk run). The tendency for growing levels of integration (computerised) among the companies has been confirmed.

Quality Systems	
General characteristics	The automotive chains show an increasing demand for and use of adequate quality systems and the implementation of quality standards (which vary according to the automaker's nationality).
Group of multinationals	All have consolidated quality systems implemented a long time ago, whose standards vary according to the company's nationality and those of their major customers. The EAP did not participate in the implementation of these quality systems.
Group of national companies	The EAP does not demand specific certifications, but requires and supports the use of certain procedures to guarantee component quality. The EAP makes a series of recommendations to these suppliers, for which reason some of the techniques previously adopted by the EAP are found at the suppliers.
Axes of variation	The axes of variation here are the company's experience with standardised practices, the number of standards for which they are certified, and the extent to which they use ongoing improvement programs.
Relations with the EAP	The EAP supports the development of small size suppliers, and the techniques used by the latter are very similar to those of the EAP. Quality standards have become an increasingly stringent requirement for the participation of companies in the autoparts sector.